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Capture – Aqueous Systems

New concept for CO_2 capture in flue gas : solvent with a lower energy of regeneration

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New concept for CO_2 capture in flue gas : solvent with a lower energy of regeneration

- Framework
- Presentation of the concept
- Experimental results
- Conclusion

Framework

CO_2 Capture in **Post combustion** with a **solvent**

- Main constraint : very low P_{CO2} ($\approx$ 0.1 bar)

To achieve **90%** capture of CO_2

$\Rightarrow$ Chemical solvent (aqueous solution of amine)

$\Rightarrow$ **High energy of regeneration of the solvent**

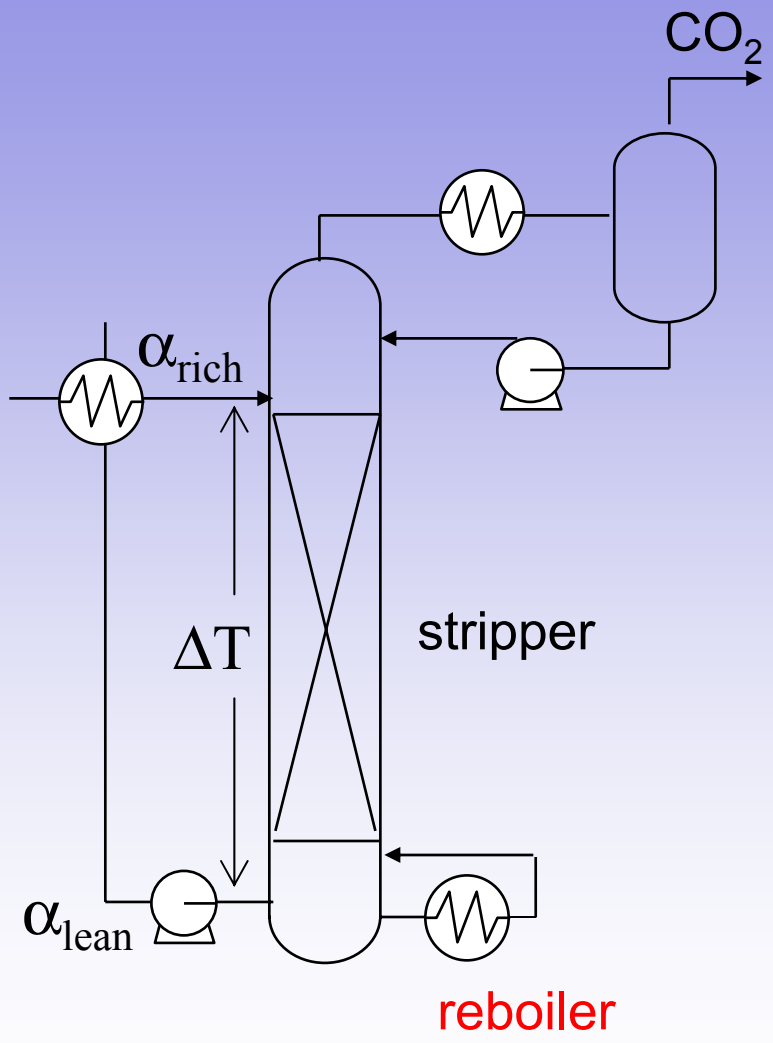
For MEA 30% (reference case) about **4 GJ/t_{CO2}.**

Means of significantly reducing CO_2 capture costs :

Reducing energy of regeneration to 2 GJ/t_{CO2}.

How can we do this with another solvent?

Energy of regeneration…



...is the sum of the energies needed for :

• heating of the solvent to boiling point

(**sensible heat**) :

~ flow rate of solvent to achieve 90% capture

~ 1/dynamic capacity ($\Delta\alpha = \alpha_{rich} - \alpha_{lean}$)

• breaking of the chemical bond

(**heat of reaction**) : enthalpy of reaction

ammonium salt ⟶ amine + CO_2

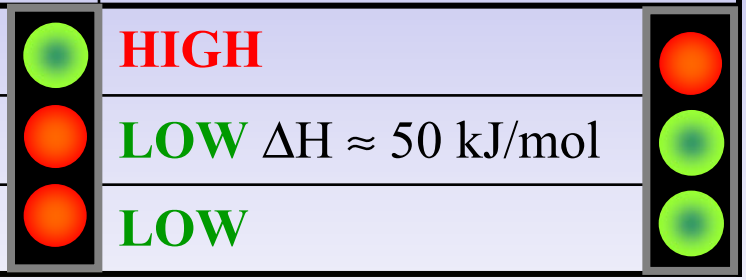
• generating steam for CO_2 stripping

(**heat of vaporization**)

Vapor Liquid Equilibrium data

Comparison between a primary amine (MEA) and a tertiary amine (MDEA)

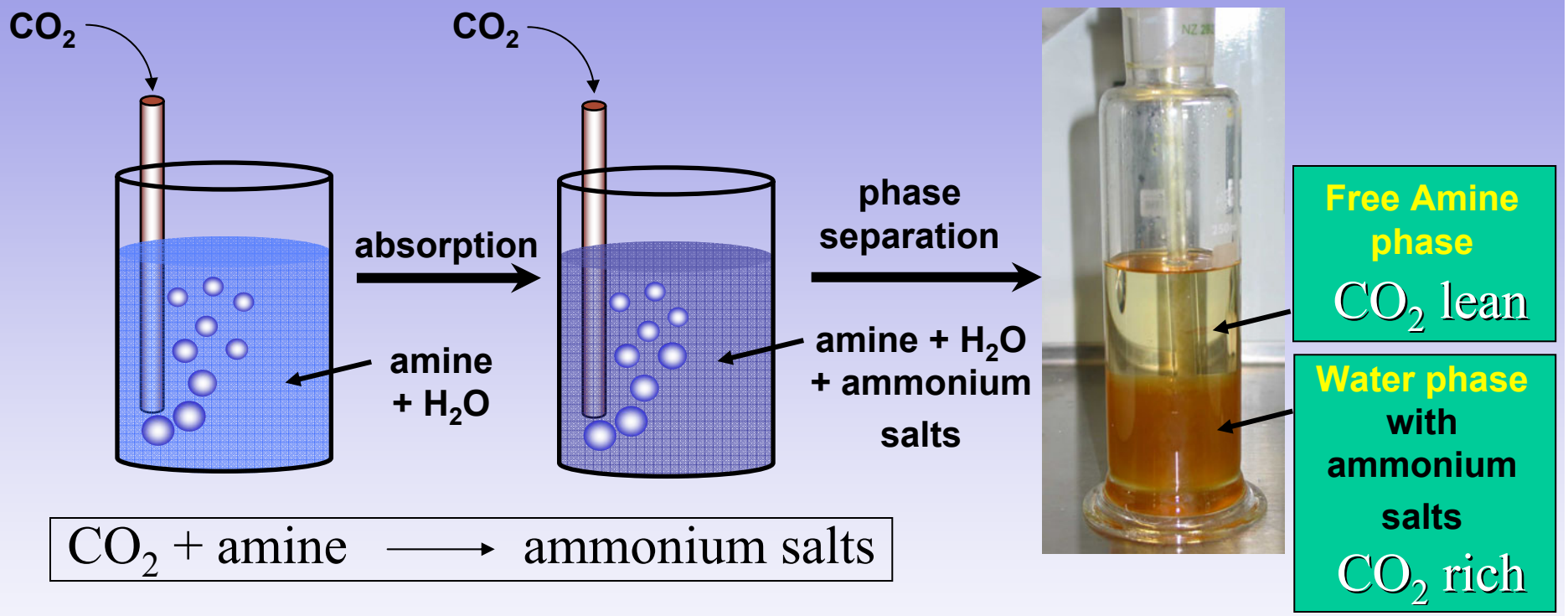
	MEA	MDEA
Dynamic capacity of the solvent at low P_{CO2}(≈ 0,1bar)	**HIGH** $\Delta\alpha \approx 0.25$	**LOW** $\Delta\alpha \approx 0.15$
Sensible heat	**LOW**	**HIGH**
Heat of reaction	**HIGH** $\Delta H \approx 85$ kJ/mol	**LOW** $\Delta H \approx 50$ kJ/mol
Heat of vaporization	**HIGH**	**LOW**



How can we reduce the heats of reaction and vaporization without increasing the sensible heat ?

New concept : principle

A specific solvent which phase separates during CO_2 capture



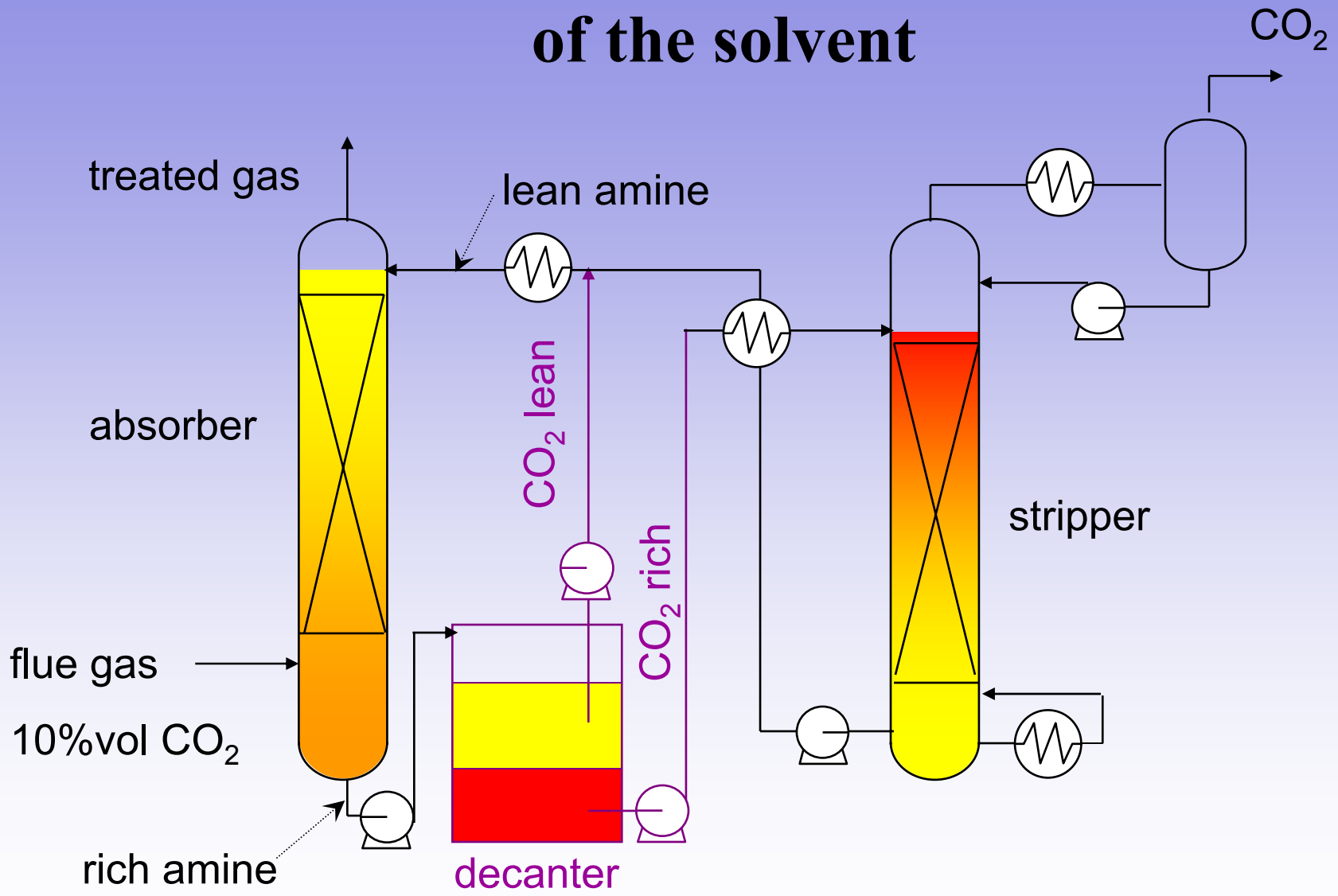
CO_2 + amine ⟶ ammonium salts

➡ **Lower sensible heat** (Regeneration of a fraction of the solvent)

Abnormally high CO_2 loading (CO_2 concentrated in one phase)

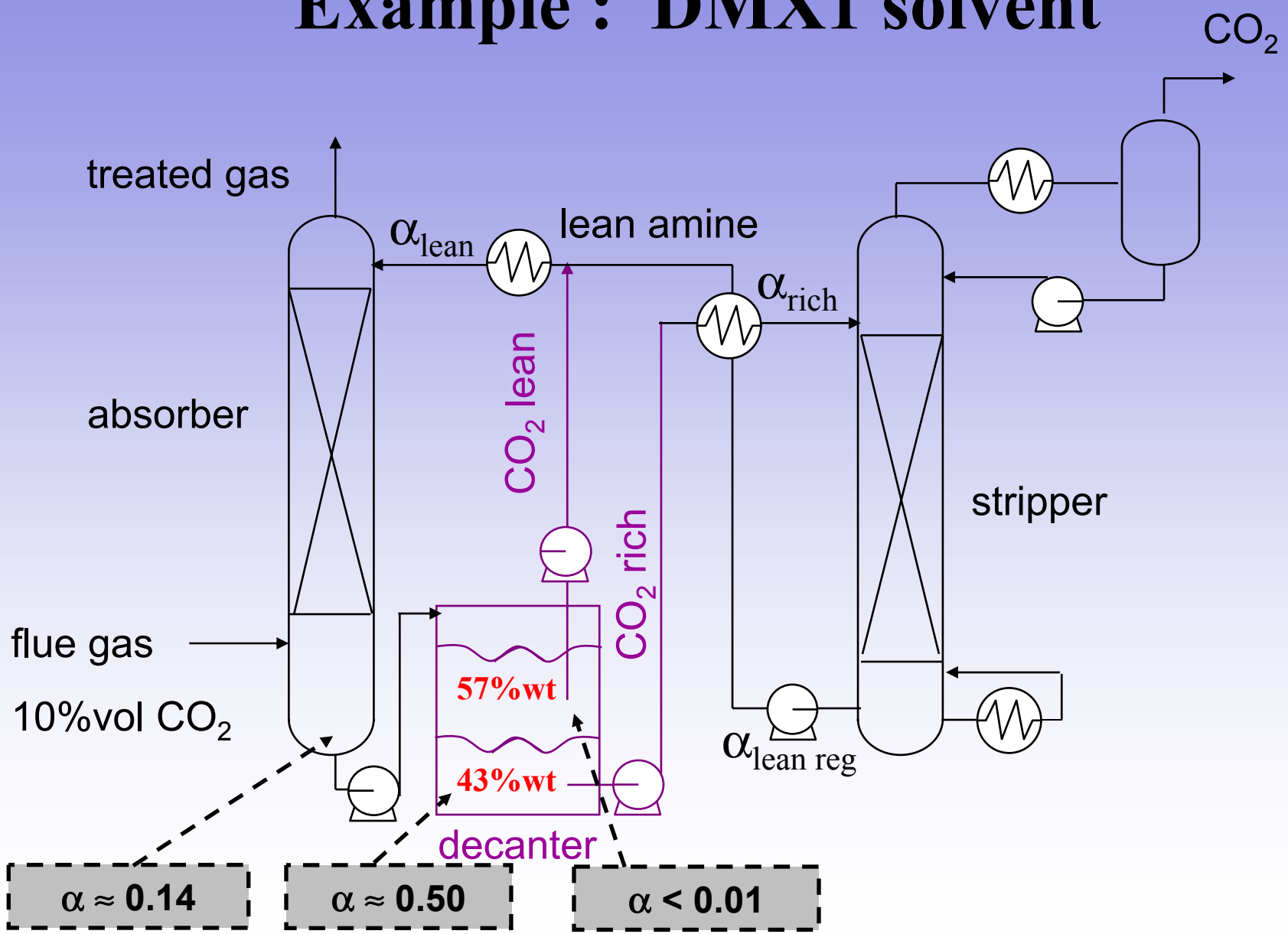
➡ **Lower energy of regeneration**

Process with regeneration of a fraction of the solvent



=> Standard process with only addition of a decanter

Example : DMX1 solvent



Energy of regeneration of DMX1

Calculation of energy of regeneration, simple model based on :

- Vapor Liquid Equilibrium data obtained at IFP
- Enthalpy of reaction : 60 kJ/mol (calorimetric measurements)
- $\alpha_{rich} = 0.50$ (at Patm, 40°C, CO_2 10%vol in N_2)
- $\alpha_{lean\ reg} < 0.01$ (at the outlet of the stripper)

Total energy : 2,5 GJ/t_{CO2}

with absorption of 90% of CO_2 (flue gas : 10%vol CO_2)

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- **Original concept with standard technology :**

  process close to standard amine treating process (+ decanter + specific solvent)

- **Interest of the concept** :

  lower energy of regeneration, about **2.5 GJ/t CO_2**